Smart Grid Deployment Plan

SDGE connected

A Sempra Energy utility℠

Smart Utility – Integration of DER

INTEGRATION OF DER

- SDG&E customers continue to install significant numbers and capacities of solar photovoltaic and other intermittent electric generation resources at residential and non-residential premises

Table ES-1: California's Top 10 Solar Cities by Generation Capacity and by Number of Installations

| City	Solar Capacity (MW$_{AC}$)	Rank by Capacity	Number of Installations	Rank by Installations
San Diego	37	1	4,507	1
Los Angeles	36	2	4,018	2
San Jose	31	3	2,733	3
Fresno	22	4	2,146	5
San Francisco	17	5	2,405	4
Bakersfield	16	6	1,643	6
Sacramento	16	7	1,119	10
Santa Rosa	14	8	1,467	7
Oakland	10	9	1,010	11
Chico	9	10	615	19
Clovis	8	11	1,133	9
Roseville	3	84	1,170	8

Data: **As of August 2011**

Source:
California's Solar Cities 2012: Leaders in the Race Toward a Clean Energy Future; Environment California, January 2012

- SDG&E is proposing and planning Smart Grid investments that increase measurement, control and management capabilities to support the integration of distributed energy resources (DER).

INTEGRATION OF DER

SDG&E Service Territory
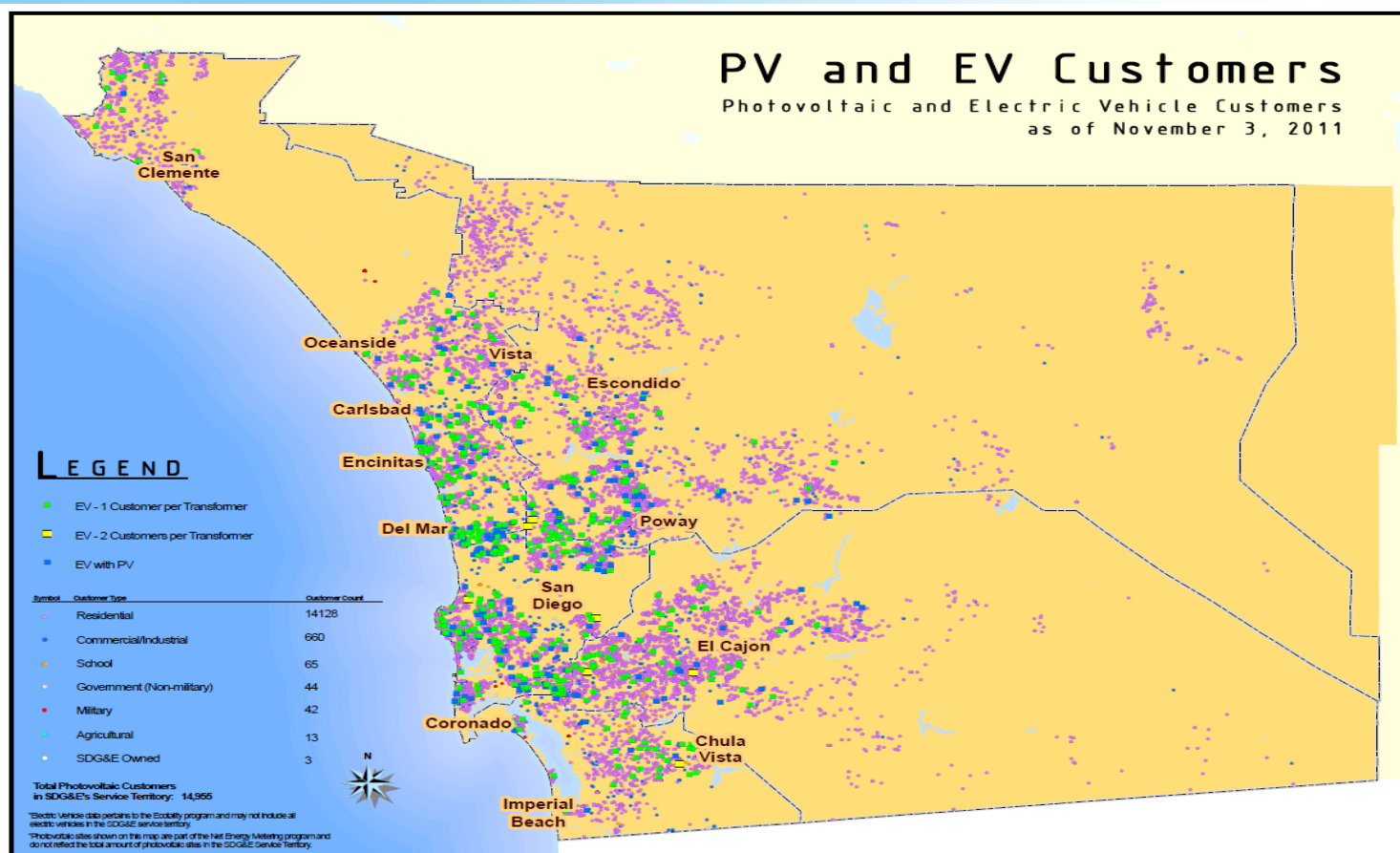
- 740 of 956 circuits have PV YE 2010
- 125 MW 15,800 installations as of YE 2011
- Residential approximately 15 MW/year

High PV Penetration Concerns

- **Operational Concerns (PV Power Variability)**

  – Monitoring and ensuring resource adequacy
  – Frequency regulation
  – Voltage regulation
  – Impact is highly location dependent (urban vs. rural)
  – O&M Impacts

- **Engineering/Planning**

  – Capacity planning (size, location, time, guaranteed production)
  – Volt/VAr planning
  – Conservation Voltage Reduction impacts
  – Electrical models
  – Transient analysis tools

- **Regulatory**

  – Rule 21
  – Rule 2
  – Cost causation
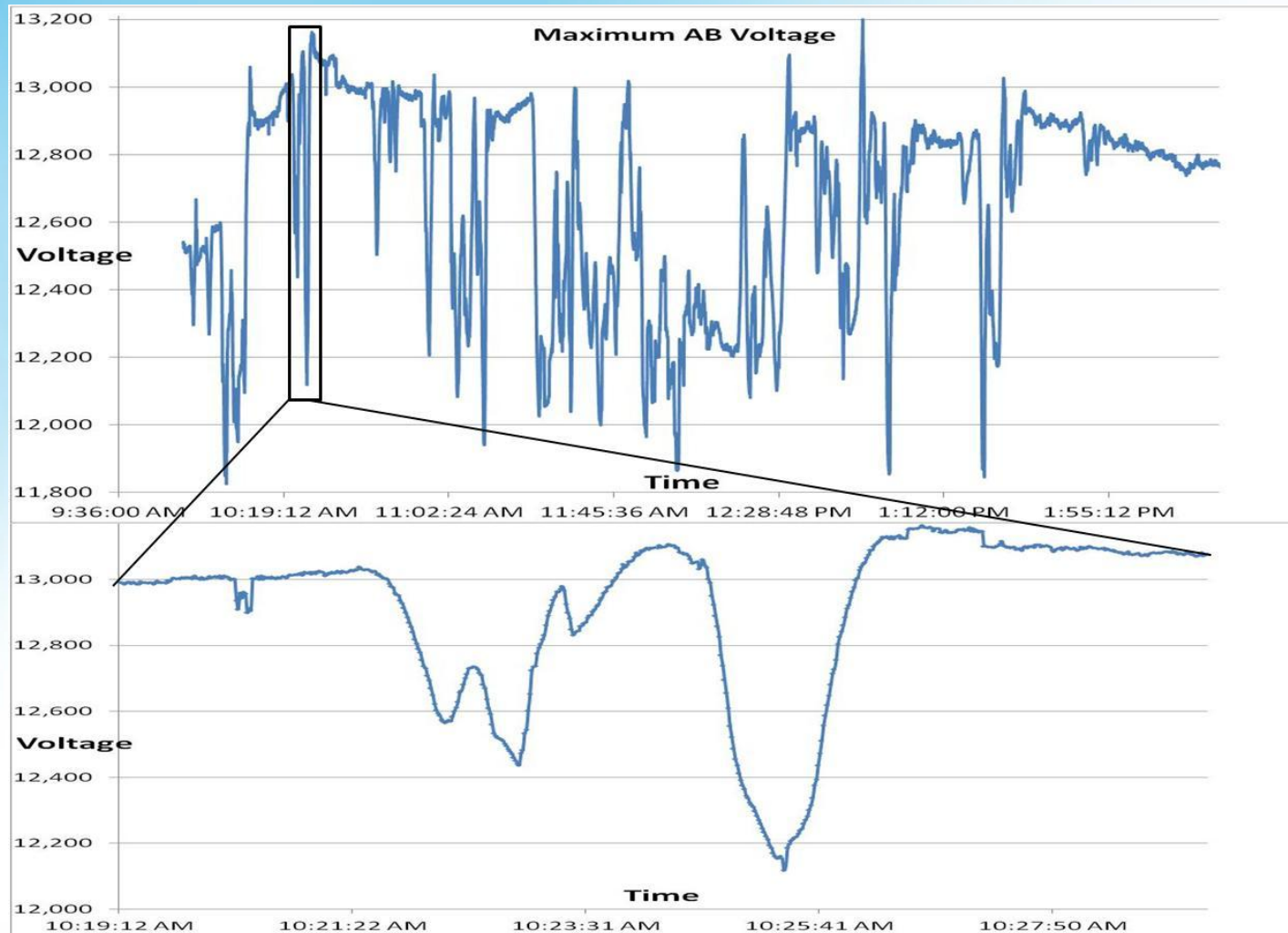
PV Intermittency

- Outside ANSI ranges
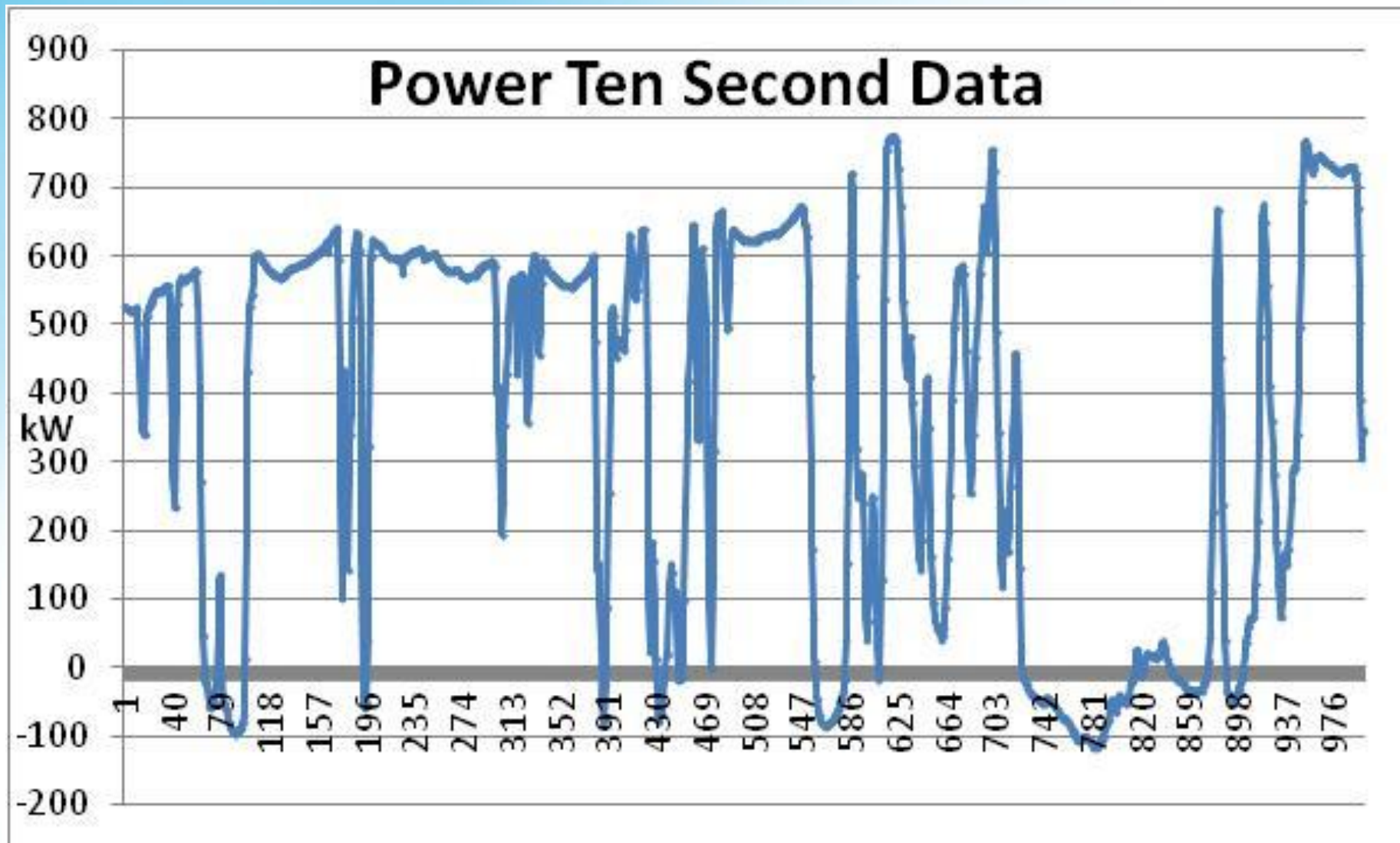- Not CVR Compliance
- CBEMA Violations
- O&M Issues
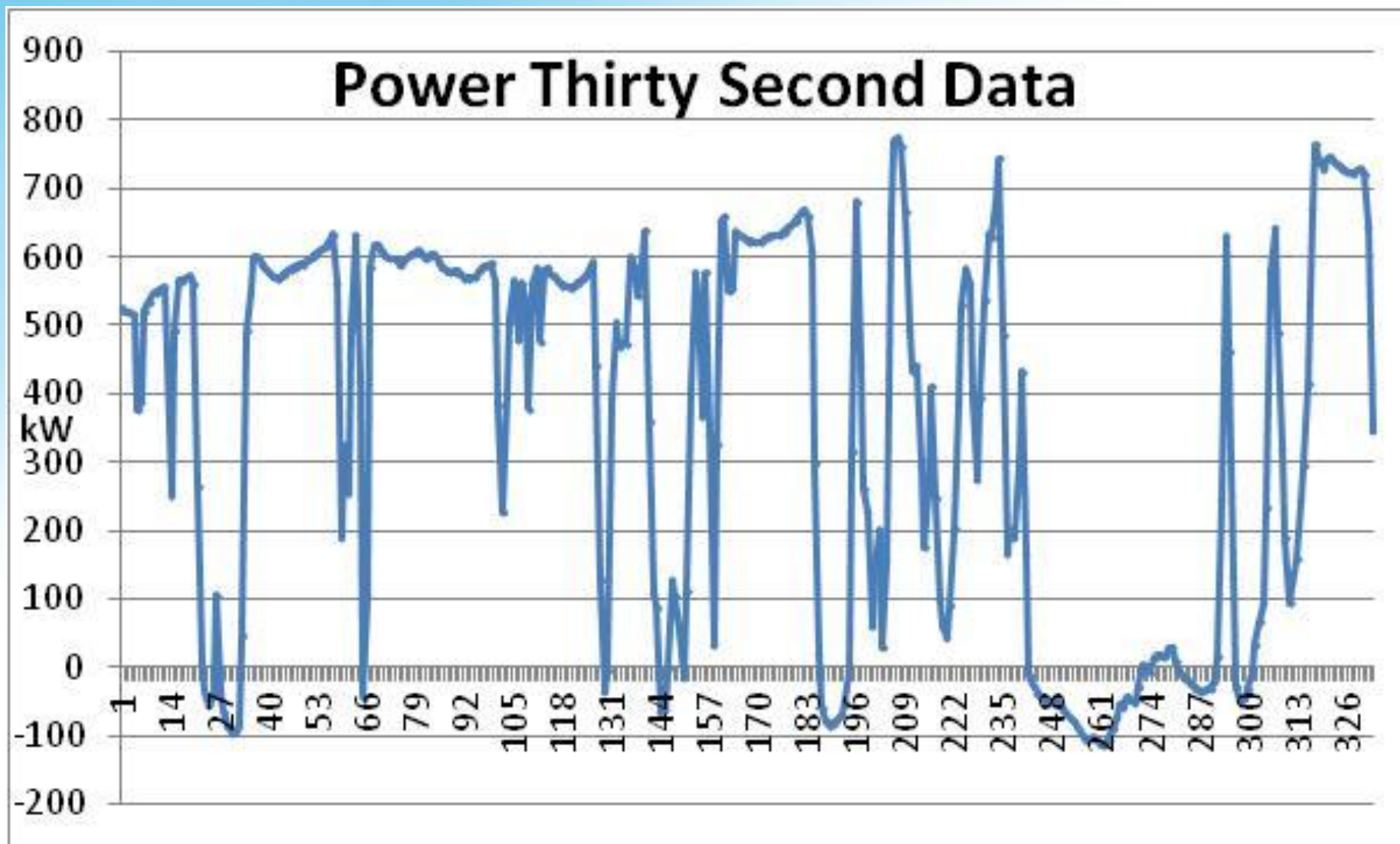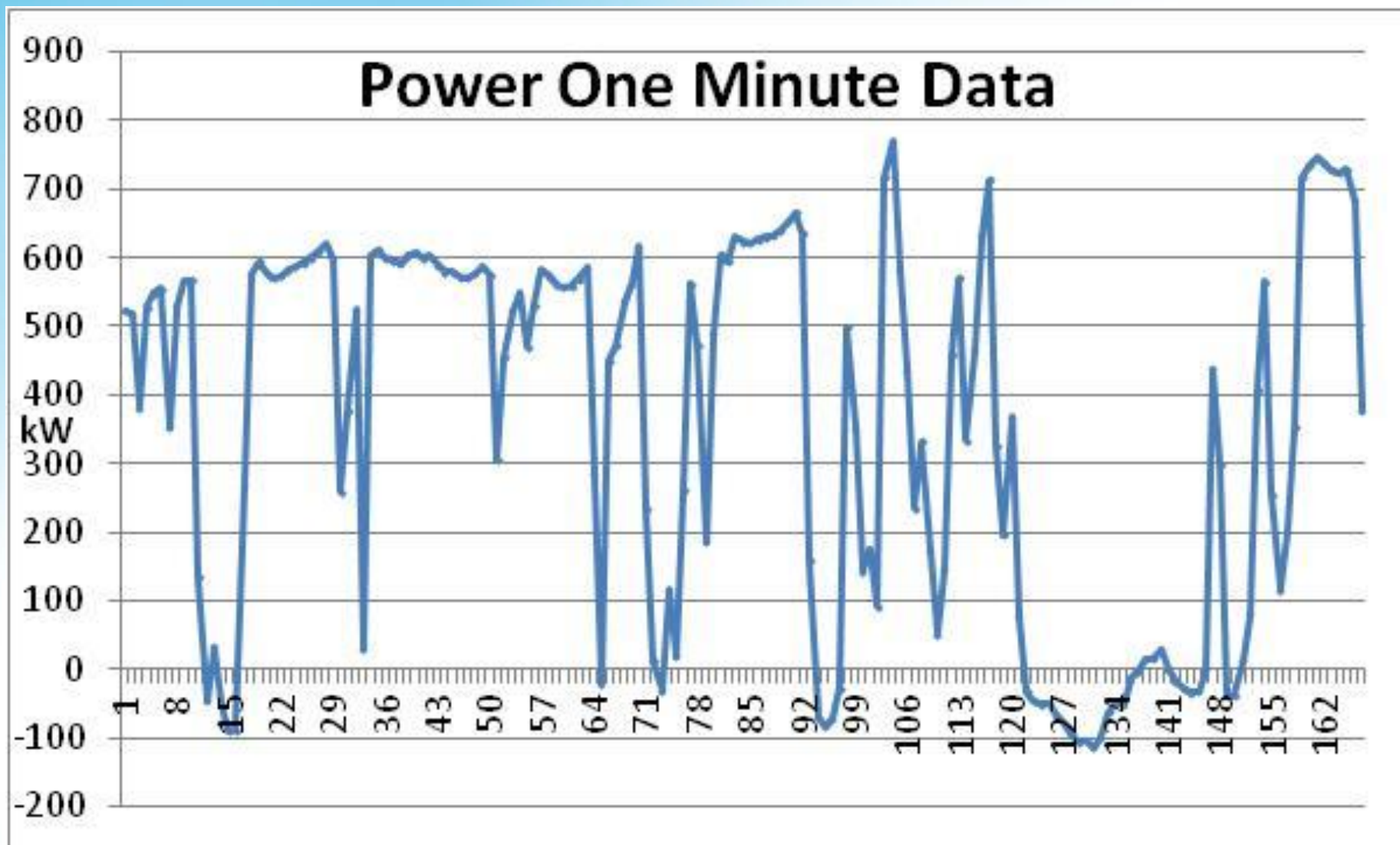
INTEGRATION OF DER

PV Intermittency

PV Intermittency

Power Ten Second Data
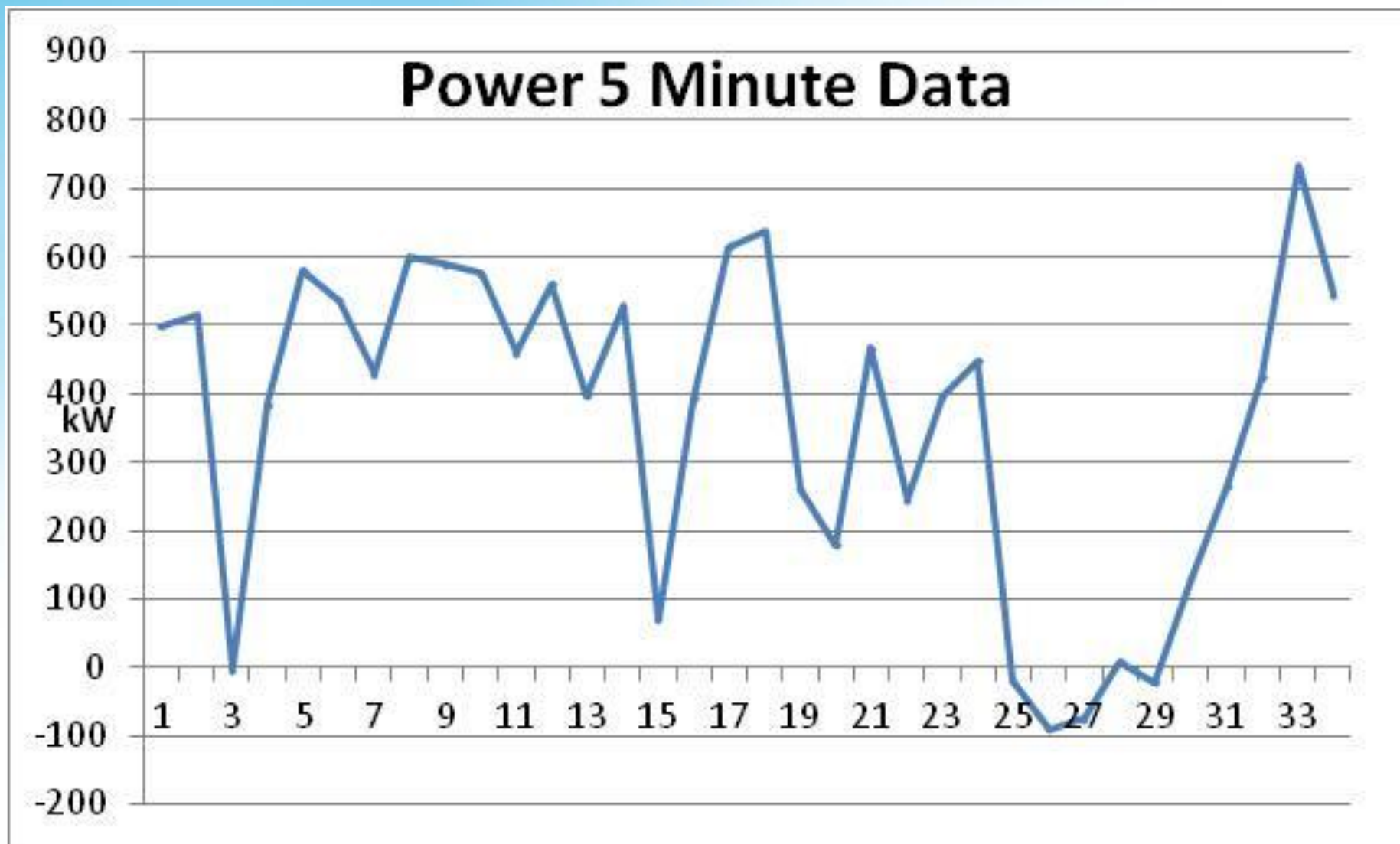
PV Intermittency

INTEGRATION OF DER

PV Intermittency

INTEGRATION OF DER

PV Intermittency

Power 5 Minute Data
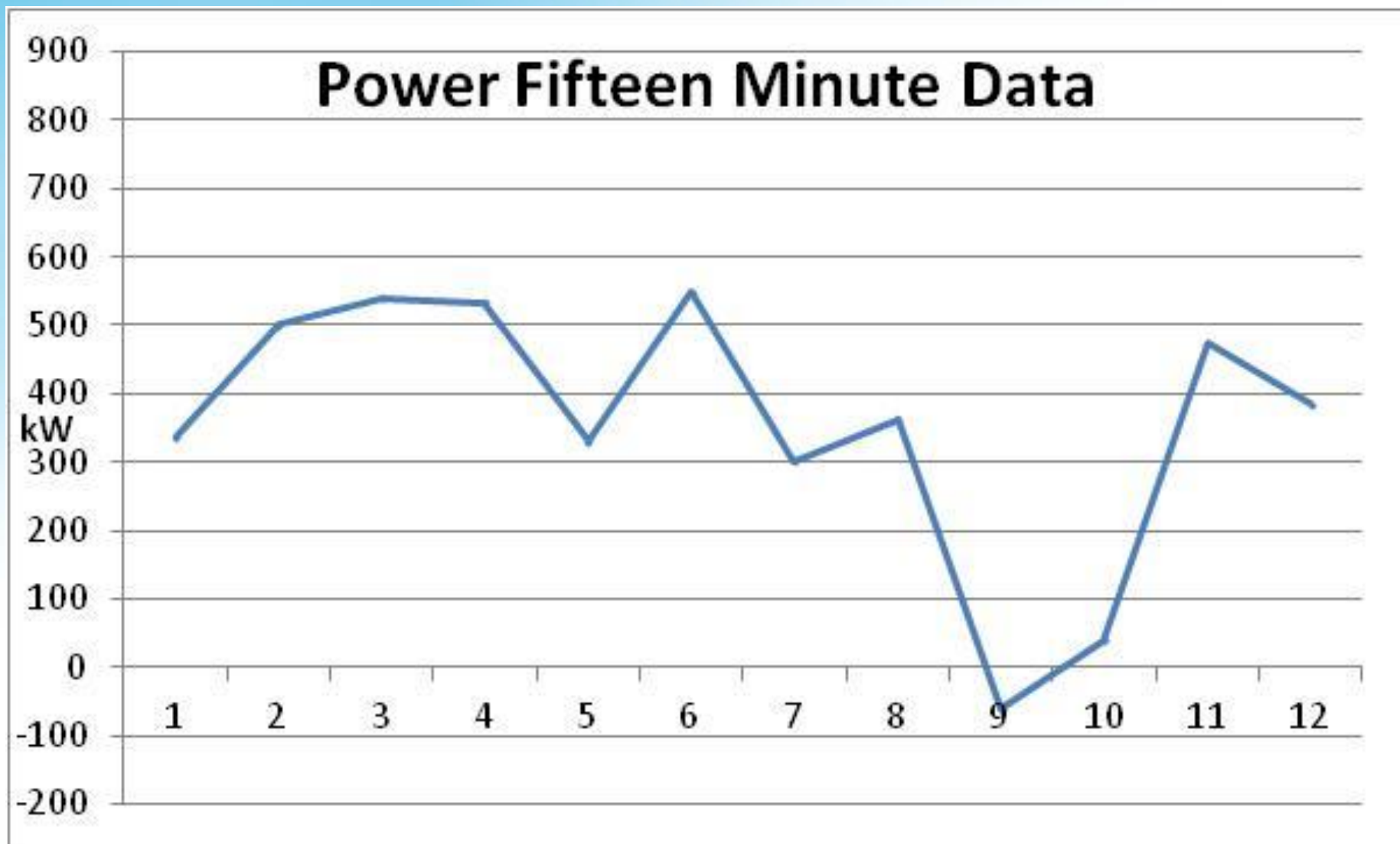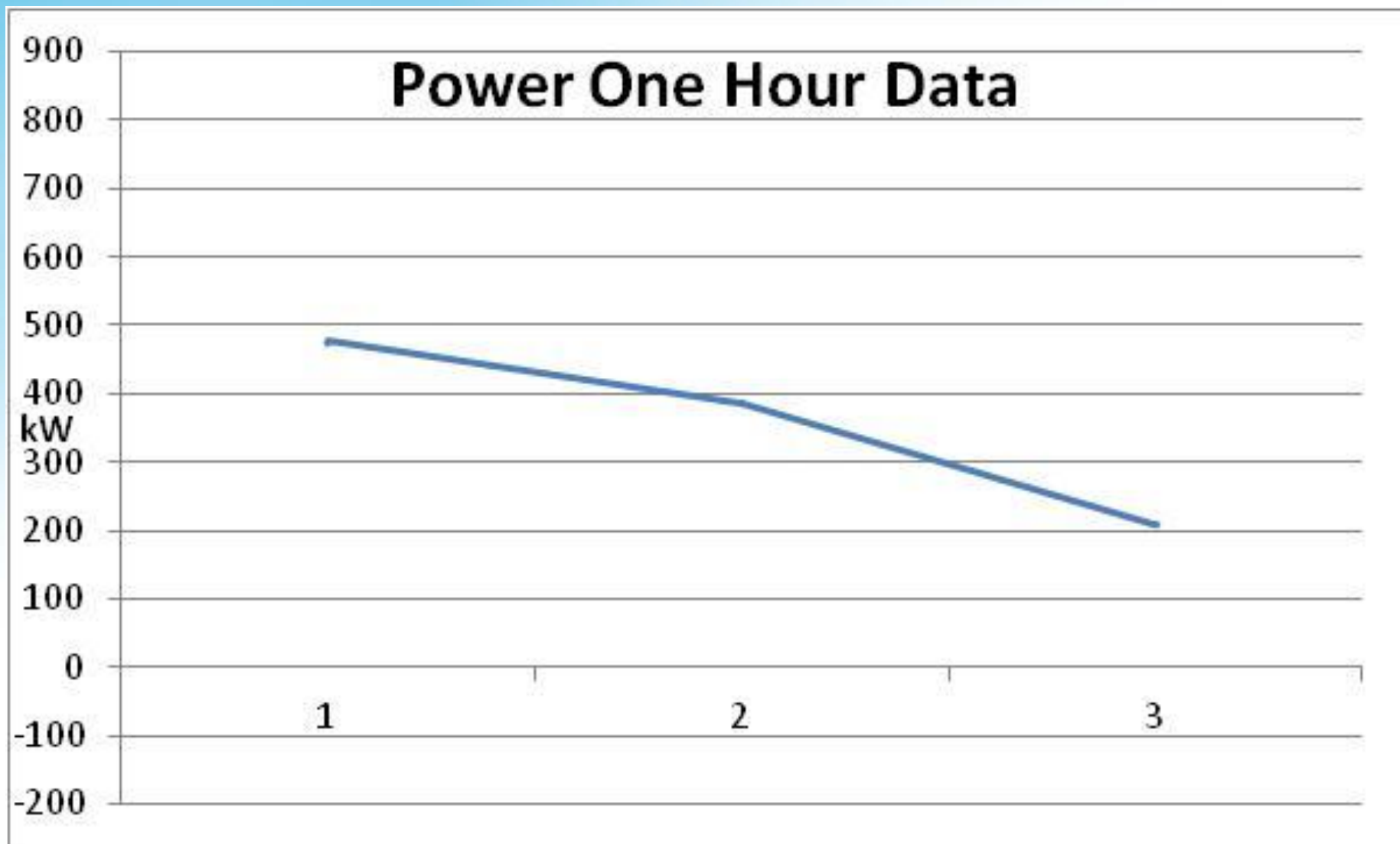
PV Intermittency

PV Intermittency

PV Intermittency

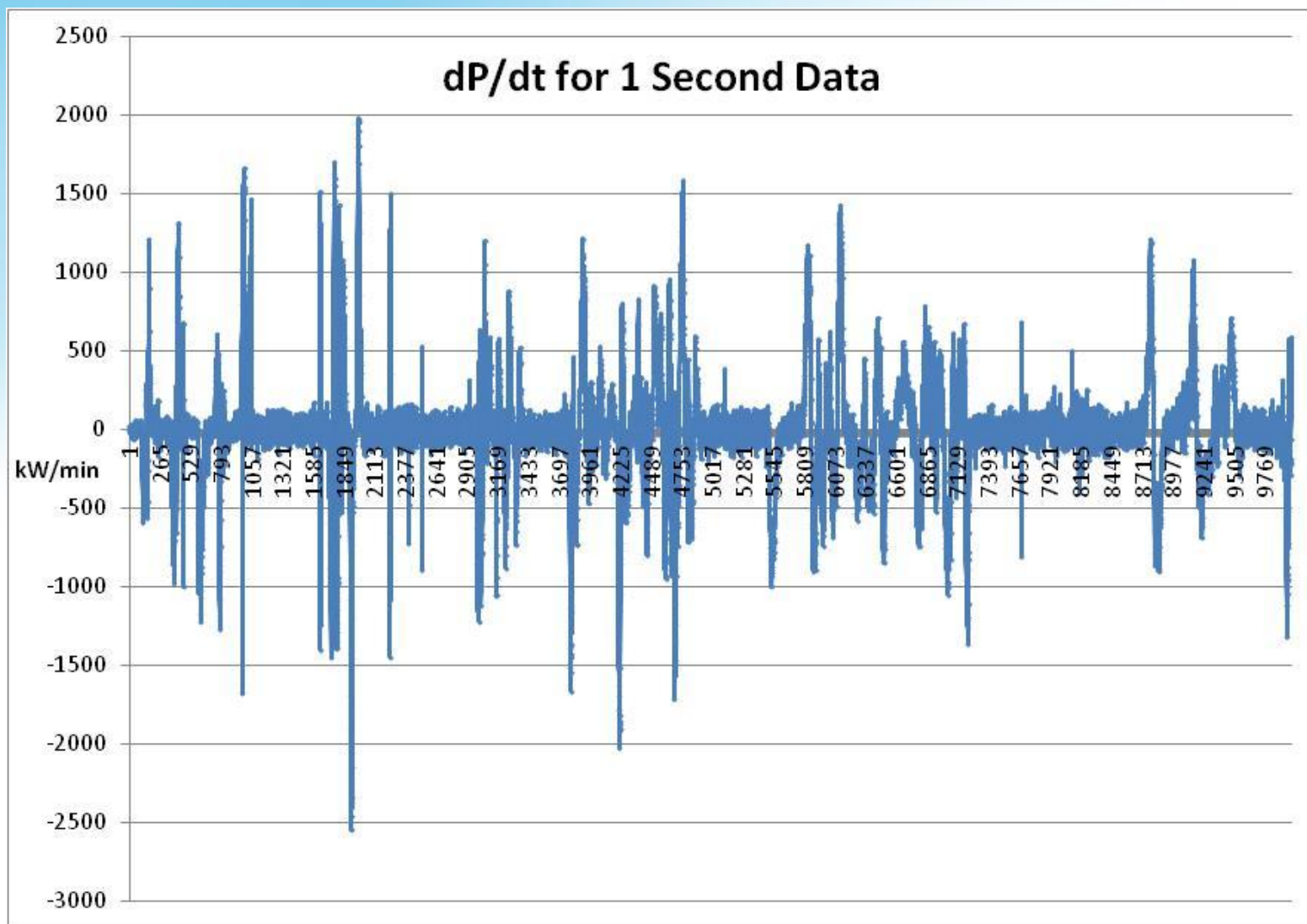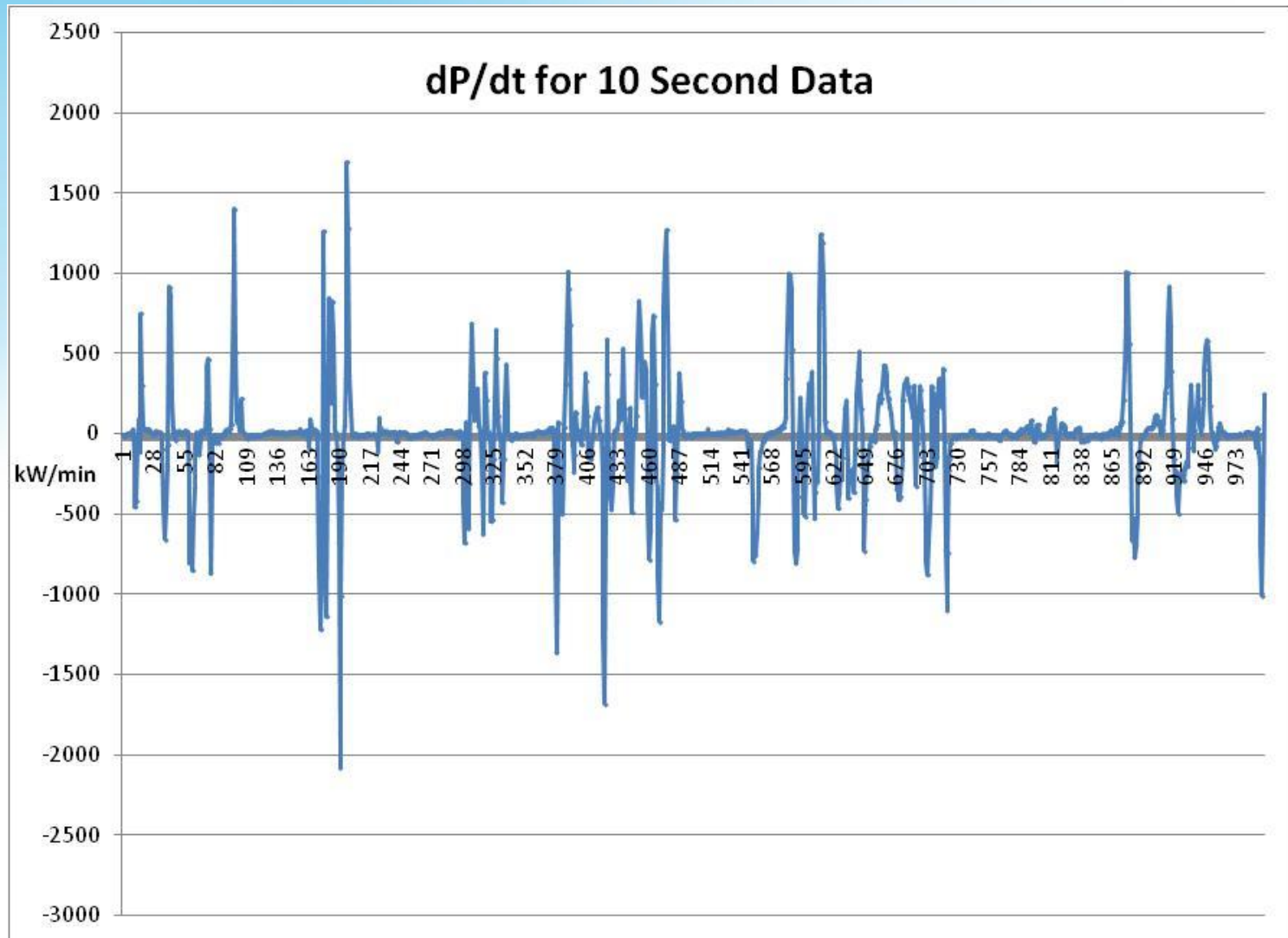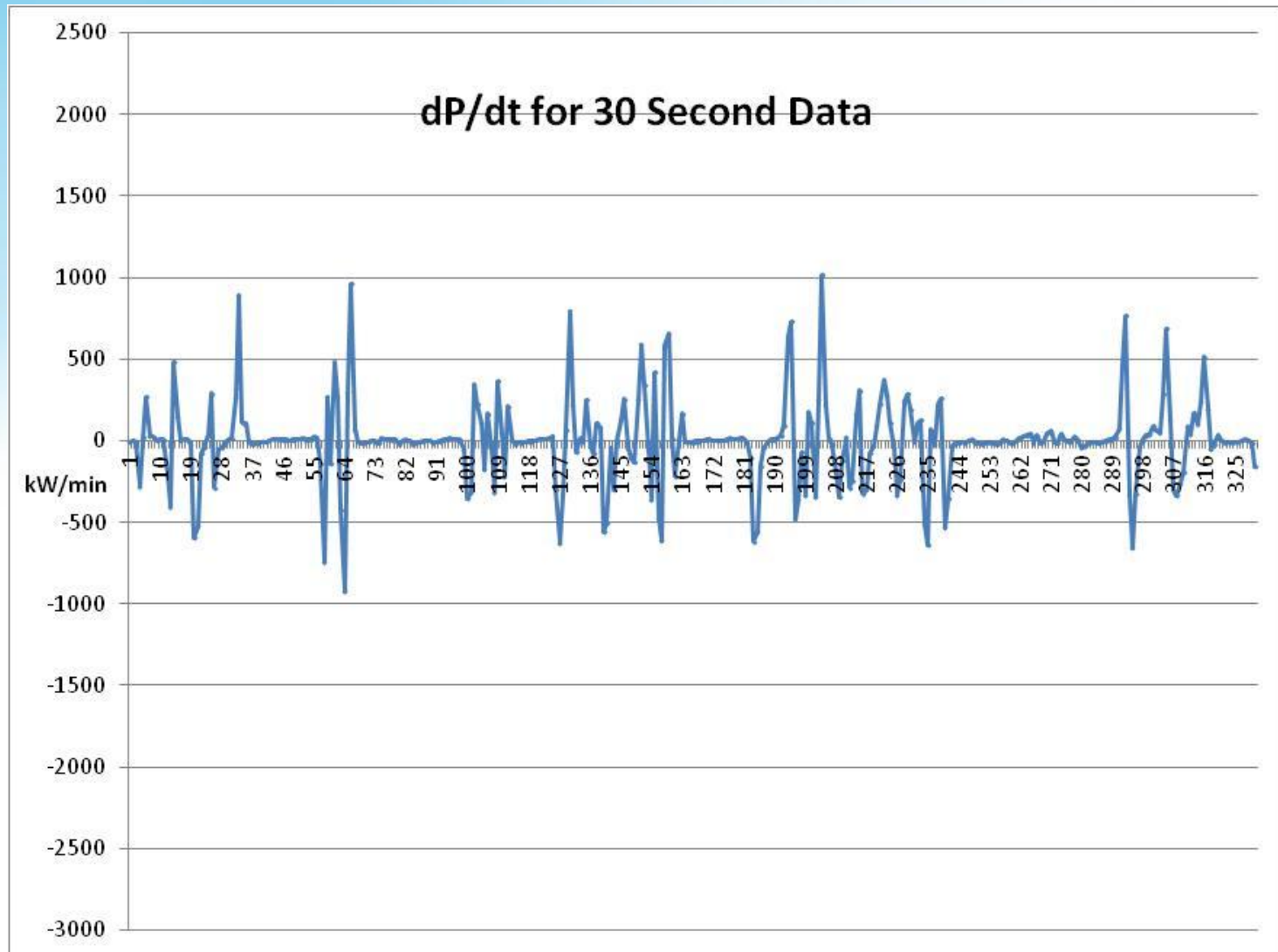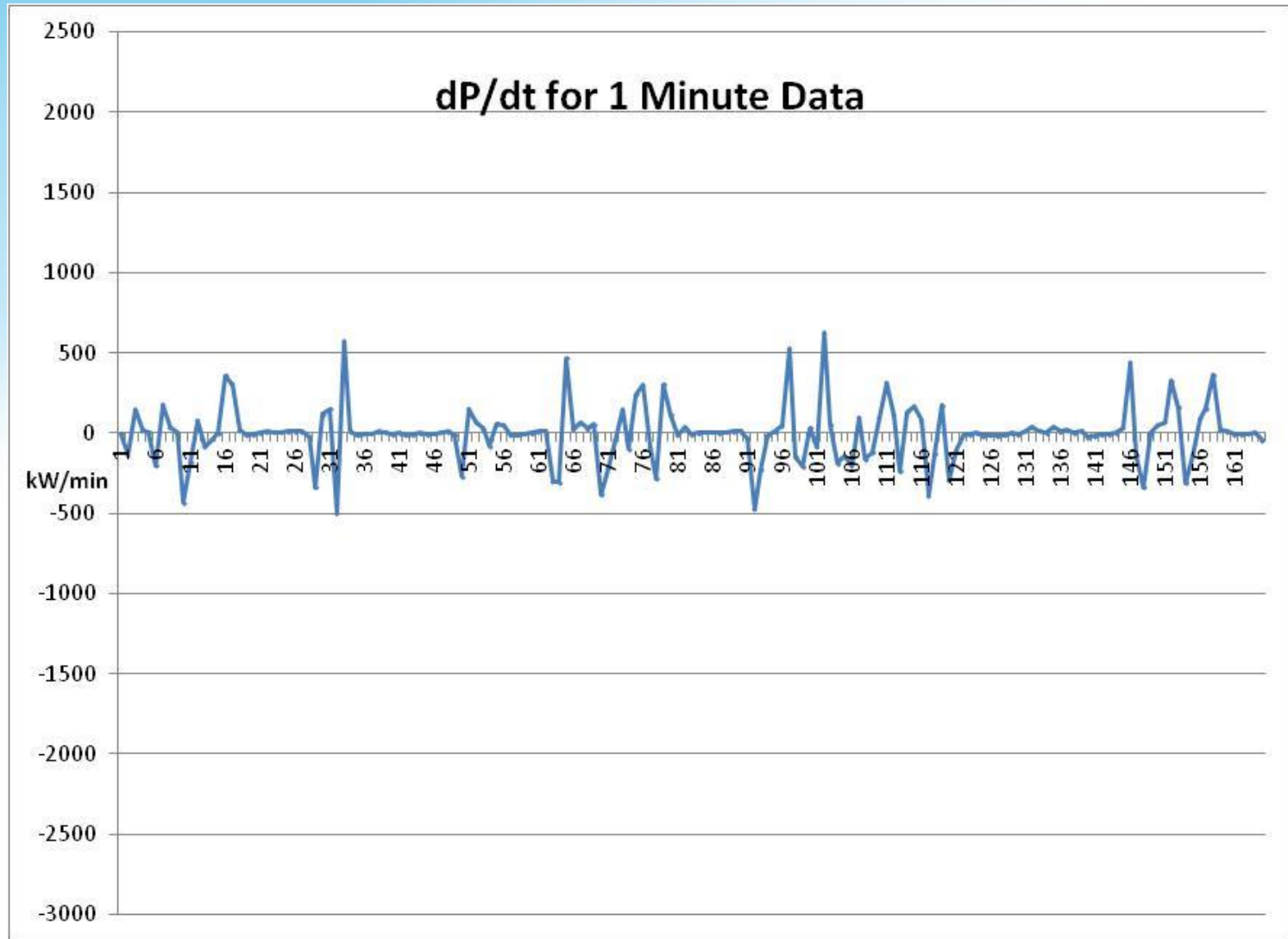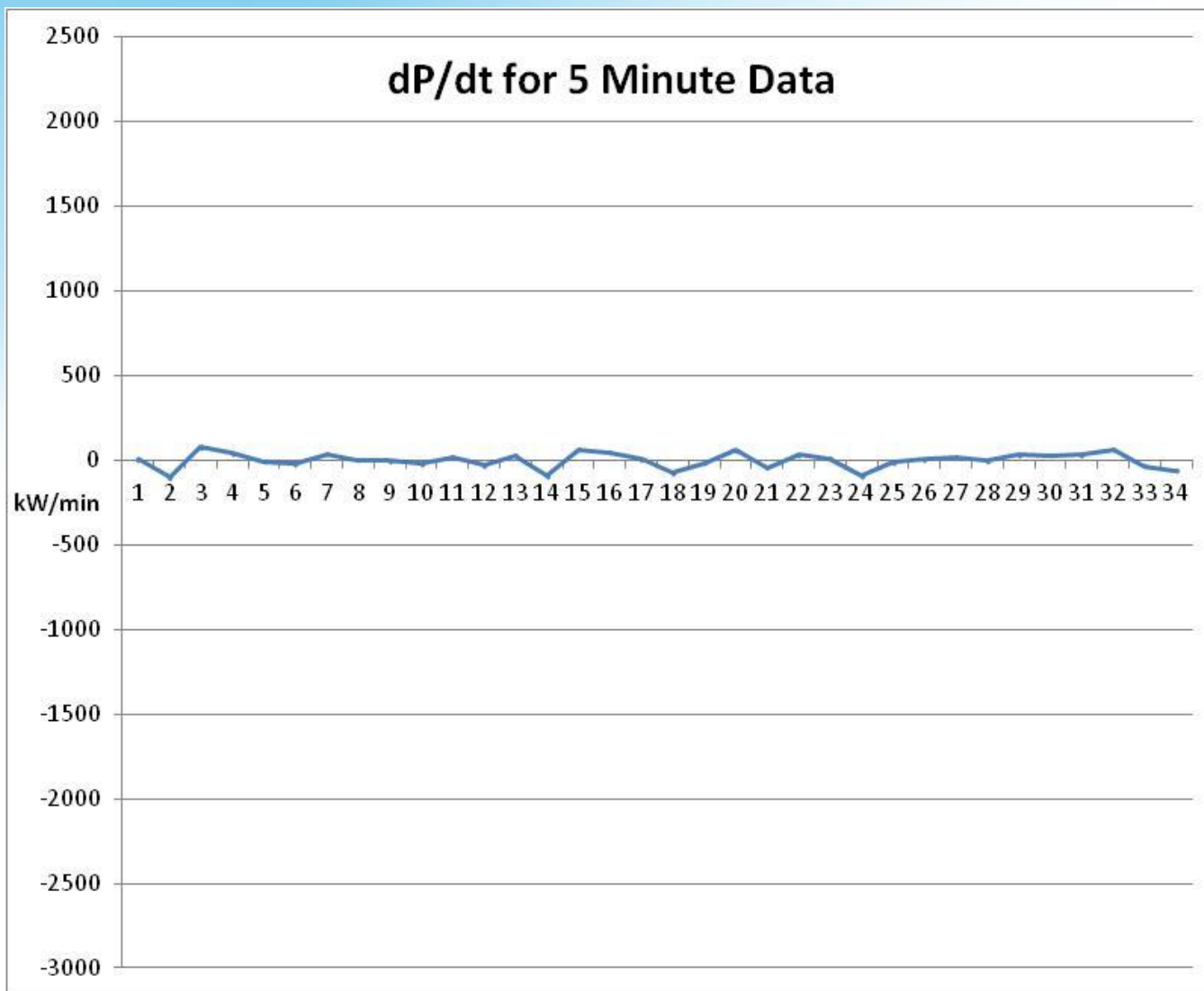## PV Intermittency

INTEGRATION OF DER

PV Intermittency

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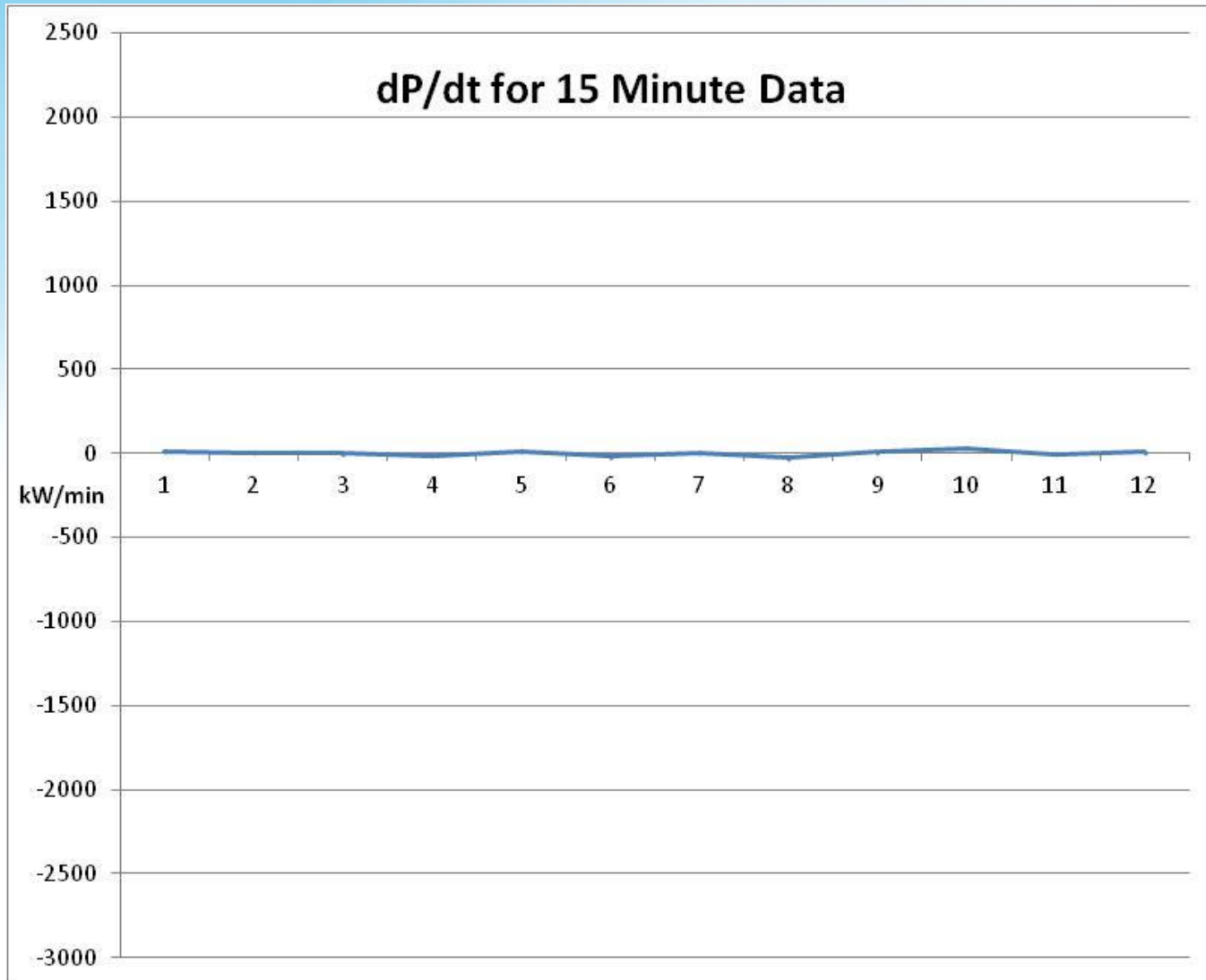
PV Intermittency

INTEGRATION OF DER

PV Intermittency

INTEGRATION OF DER

PV Penetration Threshold

ReliaSoft Weibull++ 7 - www.ReliaSoft.com

Ratio of PV Output to Load
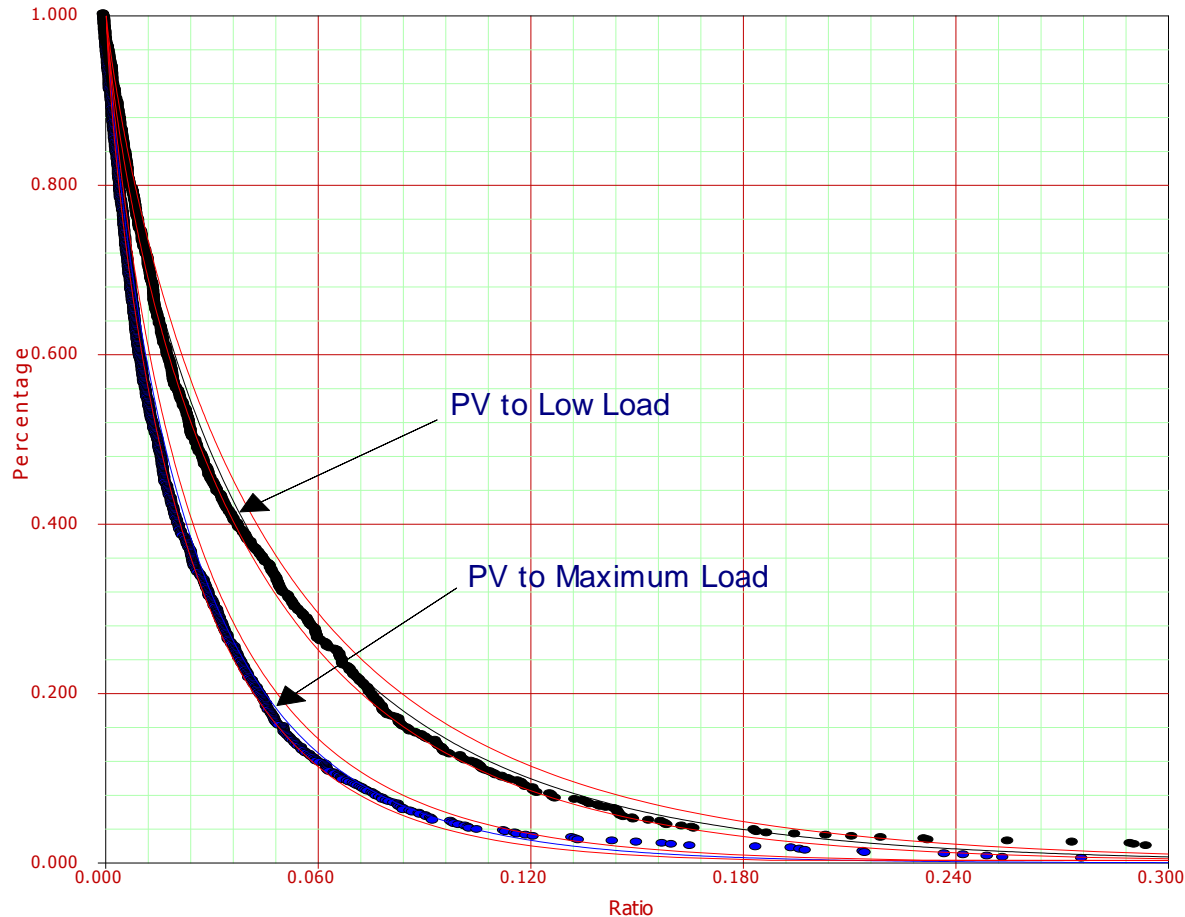
Reliability
CB@90% 2-Sided [T]

Folio1\Data 1
Weibull-3P
MLE SRM MED FM
F=732/S=0
● Data Points
— Reliability Line
— Top CB-I
— Bottom CB-I

Folio2\Data 1
Weibull-3P
MLE SRM MED FM
F=732/S=0
● Data Points
— Reliability Line
— Top CB-I
— Bottom CB-I

PV to Low Load

PV to Maximum Load

Thomas Bialek
San Diego Gas & Electric Co.
9/23/2011
11:43:22 AM

Ratio

Percentage

Folio1\Data 1: β=0.8243,α=0.0252,γ=0.0002
Folio2\Data 1: β=0.8276,α=0.0436,γ=0.0002

INTEGRATION OF DER

PV Penetration vs. Time
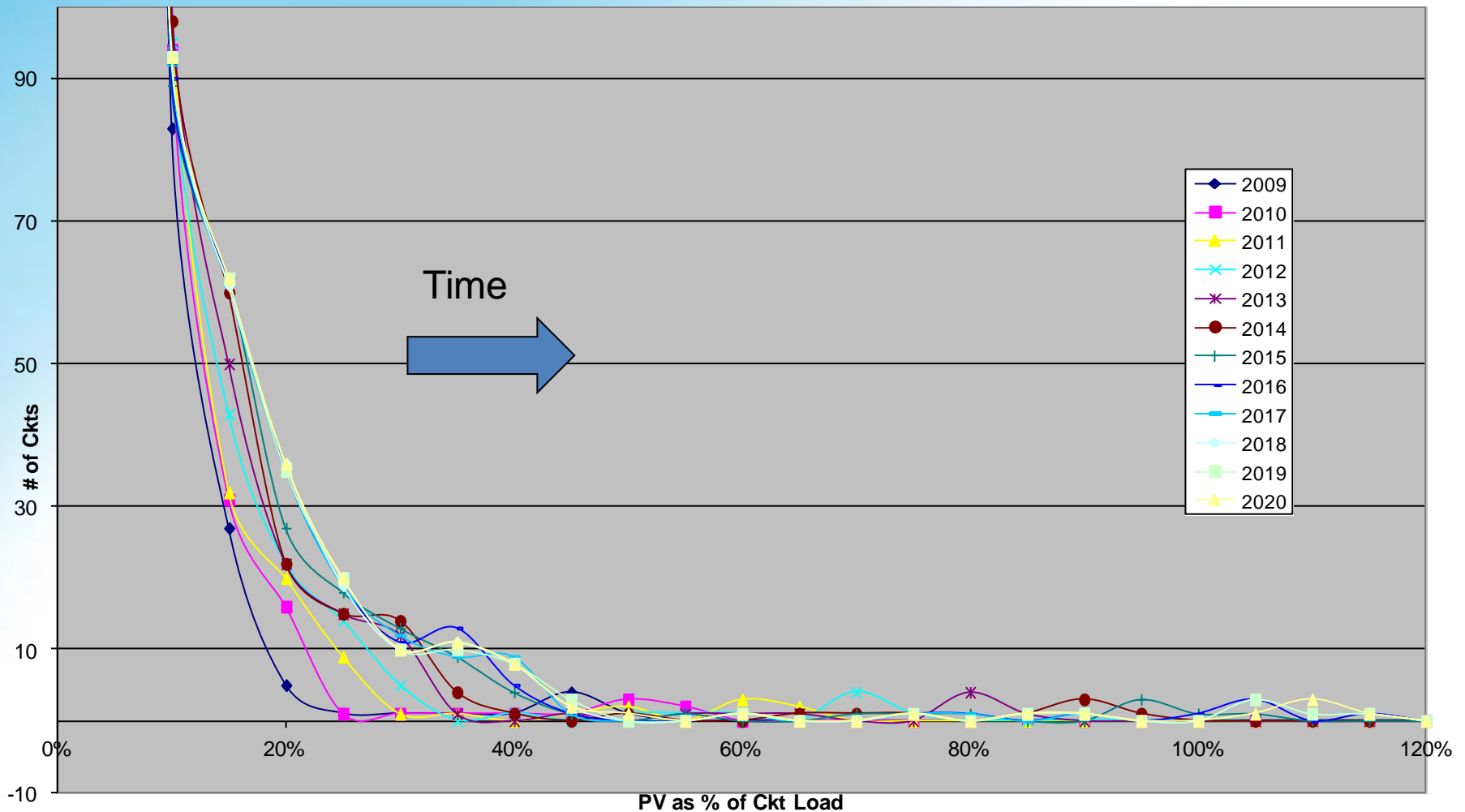
Values are for illustration only and do not represent forecast

Solutions?

- **Circuit modifications**

  – Monitoring and ensuring resource adequacy
  – Frequency regulation

- **Demand response**

  – Slower dP/dt events?

- **4 quadrant control**

  – Utility dynamic VAR devices
  – Utility storage
  – Customers inverters/storage

- **Regulatory/Standards Changes**

  – Existing rules require modification to accommodate high PV penetration
    – Draft IEEE 1547.8, IEC 61850 can be utilized today
      – Similar to German Grid Code

INTEGRATION OF DER

Demand Response

Overarching Objectives

- Maximize the availability of cost-effective Demand Response
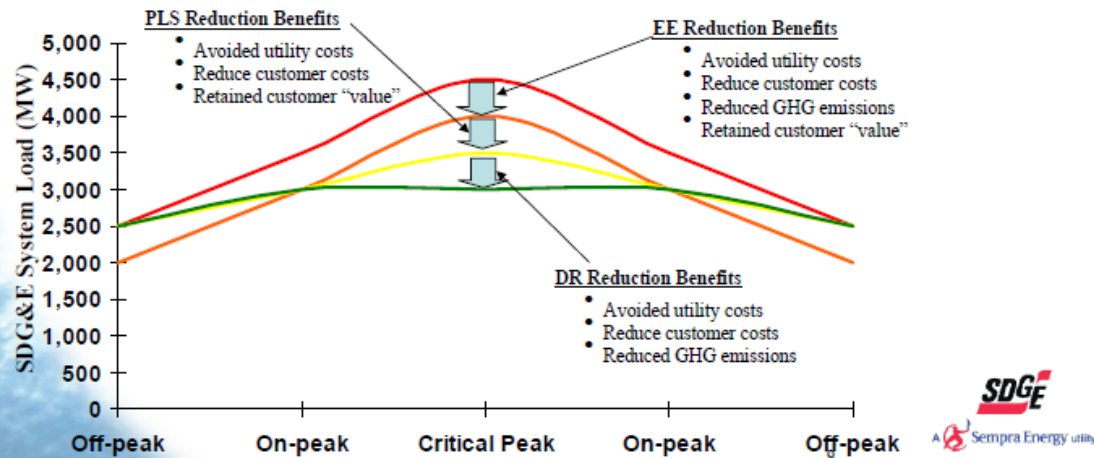- Integrate Demand Response with Energy Efficiency and Permanent Load Shifting to seek a flat utility load profile

PLS Reduction Benefits
- Avoided utility costs
- Reduce customer costs
- Retained customer "value"

EE Reduction Benefits
- Avoided utility costs
- Reduce customer costs
- Reduced GHG emissions
- Retained customer "value"

DR Reduction Benefits
- Avoided utility costs
- Reduce customer costs
- Reduced GHG emissions

SDG&E System Load (MW): 5,000 / 4,500 / 4,000 / 3,500 / 3,000 / 2,500 / 2,000 / 1,500 / 1,000 / 500 / 0

Off-peak — On-peak — Critical Peak — On-peak — Off-peak

- **Residential**
  - Summer Saver AC Cycling
  - Automated Control Technology Pilot
  - Technology Deployment Pilot
 - New Construction enablement

- **Commercial**
  - Existing Rate Programs
  - Integrate into the CAISO Markets

INTEGRATION OF DER

Plug In Electric Vehicle (PEV) Impact

- As of Year End 2011
    - Vehicles: Total 1200 (Nissan LEAF, GM Volt, Tesla, "legacy" conversions & misc.)
        - Approximately 8 kWh consumption per vehicle/day
    - Public Chargers Installed: 69 with ~10x more chargers in process

Power demand from "badly" controlled charging –
a new, potentially disruptive peak
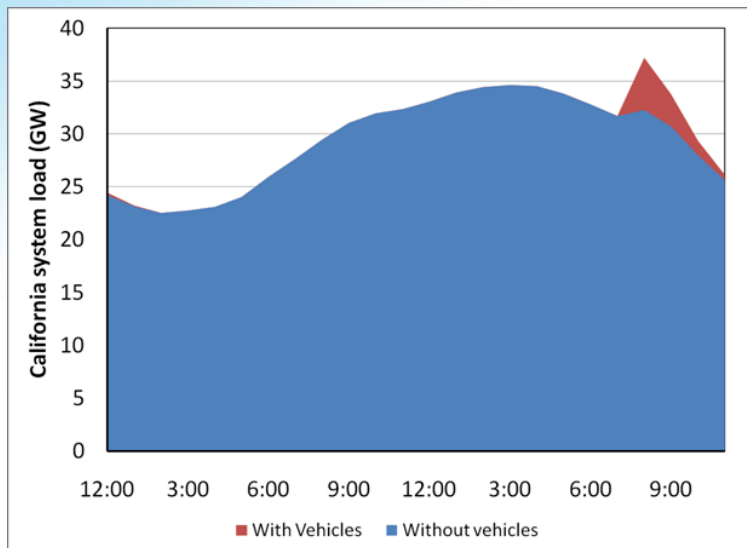
Controlled overnight charging could
result in no increase in peak load
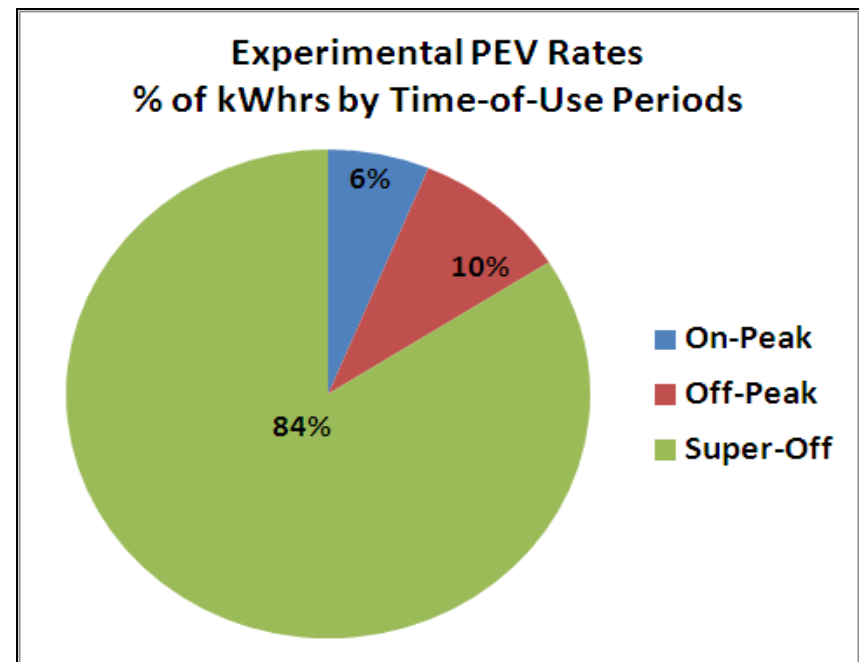
Approximately 35% of PEV experimental
rate participants are customers with solar
photovoltaic systems

Energy Storage Strategy

- **Determine the resource mix over the next 10-15 years**

  – Impact to local system

- **Estimate the actual energy output**

  – Intermittency and congestion, at various times, seasons, etc. of these resources

- **Investigate mitigation strategies for the intermittency**

  – Storage, current generation, fast ramping generation, etc.,
  – Case for why without mitigation, reliability will suffer (and how much)
  – Cost of the alternatives

- **Develop software/hardware requirements for systems that will manage load balancing in the face of increasing generation variability**

- **Compute business case for implementing mitigation strategies**

  – High level requirements, cost, pros/cons, risks, dependencies

- **Understand "true impact" of intermittent renewable resources**

  – Installed and levelized cost perspective, $/kW and $/kWh

Lessons Learned

- **Need modeling tools**

  - Transient modeling

- **Existing Rules require modification to accommodate high PV penetration**

  - Draft IEEE 1547.8, IEC 61850 can be utilized today
    - Similar to German Grid Code

- **Leverage technology for DR**

- **Attempt to control PEV impact with rates and technology**

- **Energy storage is a potential solution**

- **Need to be proactive**